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A PRELIMINARY STUDY OF THE PSYCHOLOGY OF THE ENGLISH SPARROW.

(From the Psychological Laboratory of Indiana University.)

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The present study was begun in the autumn of 1901 at the suggestion of Professor Ernest H. Lindley.[1] Since that time the study has come to include a comparative study of the English Sparrow with other birds, especially closely related species—this comparative study to be both psychological and neurological. Although something has been done in the study of other species and on the brain of the English Sparrow, the present paper will deal almost exclusively with the psychology of this bird.

There are many reasons for making the present study. First, the mental life of mature birds has not yet been very thoroughly investigated. The work of Professors Morgan, Mills, Thorndike and others with young birds has brought out some facts that are also half true for adult birds, and Hachet-Souplet, in his training of "pigeons, some of the Gallinæ, sparrows, etc.," has shown how easily and rapidly associations may be established and habits of reaction formed.[2] But no one has made a

[1] I am also indebted to Dr. Lindley for help throughout in devising of experiments and in the interpretation of results; to Professor J. A. Bergström for his sympathy and helpful suggestions. Also to Professor E. C. Sanford for helpful advice in the final preparation of the manuscript, and to Mr. Louis N. Wilson for his kind help in securing the necessary references.

[2] Hachet-Souplet: Examen psychologique des Animaux, p. 37; also Le Dressage des Animaux, pp. 192-194.

study of the psychical life of mature birds which shows the full range of their ability to profit by experience, to discriminate, to inhibit useless actions and reinforce useful ones.

Secondly, something should be done to determine whether the English Sparrow is more intelligent than other birds which he has driven out; to explain to what it is due that he has made such a signal success in adapting himself to the new conditions in the forty years which have elapsed since the first English Sparrows were imported into the United States.

It is surprising how rapidly this bird came into prominence in an economic and scientific way. In 1879 Dr. Coues, in an article which had for its main motive the prevention of the further spread of this bird into the Western Territories, gave a bibliography of 210 different articles on the sparrow written since 1867. This great interest was also attested by the fact that Dr. C. Hart Merriam made it the subject of the first Bulletin issued by the Division of Mammalogy and Entomology of the Department of Agriculture, under the title of "The English Sparrow in its Relation to Agriculture."[1] This large and splendid monograph was based on answers received to a set of questions sent out from Washington and on scientific investigations wherever possible. The great majority of persons answering the questions agreed that the English Sparrow drives out most other birds, often those much larger than himself, and that he has few successful enemies; even cats succeed in killing very few of either the old or the young. Recent observations go to show that the English Sparrow exhibits a relatively wide range of adaptability in the choice of nesting places. According to a very competent observer they now use the holes in banks in the West made by Cliff Swallows, and I have seen a male sparrow do his best to persuade a female that a hole in an electric-light pole was the very best place for a nest. They also apparently live very peaceably with Pigeons in the houses of the latter and another observer has reported to me that he observed a fight between a Red-headed Woodpecker and a Sparrow in which the former was driven away even after he had gone down into what may very well have been his nest and pulled the sparrow out by the feathers of the head.

Mr. Will T. Hill[2] and Mr. Otto Widman,[3] both of whose articles Dr. Merriam gives in full, have something to say of the English Sparrow's intelligence and would most fully, I think,

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[1] Prepared under the direction of Dr. C. Hart Merriam by Walter B. Barrows.

[2] Will T. Hill: American Field, Jan. 14, 1888.

[3] Otto Widman: History of the House Sparrow, *Passer Domesticus*, and the European Tree Sparrow, *Passer Montanus*, at St. Louis, Mo., pp. 191-194, of Bulletin No. 1 of U. S. Dept. of Agriculture cited above.

agree with Brehm who writes as follows: "It is characteristic of the Sparrow that wherever he goes he lives in the most intimate relations with man. . . . Well gifted mentally he has acquired little by little a knowledge of man and his customs. Everywhere and under all circumstances he controls his actions in obtaining his food in the most exact manner. Accordingly he is an entirely different bird in the city from what he is in the country, where he is careless, trustful, and obtrusive. But where he must suffer the consequences he is cautious, sly, and always cunning. Nothing that may be useful or harmful to him escapes his sharp glance. His rules of action based on his own experience last him from year to year and this may be used to recognize the old from the young as the wise from the foolish. As with man he lives also with other animals in a more or less friendly relation, trusting the dog, forcing himself on the horse, warning his fellows and other birds of the approach of the cat, stealing from the chickens, . . ." [1]

And Mr. Hill, of Indianapolis, Indiana, who has kindly furnished me with most of my birds and who has made it his sole business since 1887 to catch the English Sparrow for trap-shooting, says in a letter of recent date, "The English Sparrow has an intelligence peculiar to itself. Being only where man and man's works are and by familiarity it often displays wonderful judgment in that which is harmful to it and that which is not. I think it is the most intelligent of all small birds. Almost any bird can be caught by simple methods, but the only successful way to catch sparrows is to cause it to act impulsively before it has time to think twice. 'Intelligent' hardly tells it, he 's too much for me. I once had 63 varieties of native birds in captivity at one time."

"The history of the sparrow begins with the history of man, and there is every reason to believe that this bird was well known to the people of whom we have no written history; certainly frequent mention of it is made in the histories of the earliest civilizations of Europe. The sparrow is repeatedly mentioned by Aristotle and by almost every European writer on natural history who succeeded him."[2] It would be strange if this bird which has lived in such close proximity to man for such a period of time, and has made man, in spite of himself, feed and shelter him, did not show something of the same mental superiority which, for the same reason, is claimed for the dog, rat, horse, and some squirrels.[3]

This very brief statement will suffice to show what was in

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[1] Brehm: Theirleben, Zweite Abtheilung. Vögel. Zweiter Band. pp. 314-315.

[2] Merriam & Barrows: *op. cit.*, p. 301.

[3] Wesley Mills: Animal Intelligence, p. 74.

mind in beginning the present study, and I hope to be able later, in connection with the comparative study proper, to describe more fully the English Sparrow as he is in real life.

Observations and Experiments on Free Sparrows: Method of Approaching Food.

My first step was to study the way in which English Sparrows approach their food. Dr. Lindley had noted many times that they first alighted some distance away from it and approached gradually by short hops. On observing I noted the same thing. To obtain some quantitative expression for this, I laid off in a back yard a plot twenty feet square, and divided it into one hundred smaller squares, two feet each way. In the centre was marked off a square one foot each way. In this I placed the food. The strips of cloth used to mark off the squares were of a brown color, as nearly as possible the same as that of the soil and dead grass. My place of hiding was some fifteen feet away. They were frequently disturbed, but returned readily and I was enabled to repeat my observations as long as I wished. The food used was a mixture, half-and-half of cracked wheat and corn. I first put out food on November 14 at 6.30 A.M. All the observations were made about this time on following days. The birds did not find the food until the fourth day when I made it more conspicuous by placing with it some soaked bread. Then it was only a few minutes until they began to come. I held in my hand a reduced plot (3/8 of an inch to the foot) and placed a dot to mark the place of alighting of each sparrow. I watched for fifteen minutes each morning. The number of different birds was rather difficult to obtain, but ranged from three to fifteen. The number increased as the experiment progressed, except for the last two or three days. By measuring the distance of each dot from the centre on my reduced plot, getting the average and making the reduction, the following table was obtained:

Date.	No. of Visits to Food.	Average Distance (in inches).
Nov. 17	40	46.5
" 18	23	38.2
" 19	60	34.1
" 20	53	34
" 21	62	21
" 22	46	26.3
" 25	48	22.9
" 26	56	23
" 27	60	20.9
" 28	103	16.4

Date.	No. of Visits to Food.	Average Distance (in inches).
Nov. 29	60	23.7
" 30	85	13.8
Dec. 1	7	13
" 2	25	24.7
" 3	27	21.7

These results show a considerable reduction in the distance at which the birds alight from the food; and yet many of the birds never came to alight directly on the food. My observation since, both in the laboratory and outside, point to the same method of approach. The reduction, however, is somewhat greater than the table shows for the food was spread out over the space in the centre and after becoming accustomed to the place they came in such great numbers and kept changing so rapidly that I could not put down dots fast enough.

I am convinced from the wariness which they showed in so many ways in this experiment, and in my work with them in captivity, that this method of approaching their food is fairly well established, and like the "agoraphobia" of some animals perhaps does not disappear in a short time even when the necessity for it is no longer present.

This experiment showed also the readiness with which English Sparrows learn to associate. They learned to come to the trees and grape-arbor near by as soon as I began to turn a chain-pump, which I did the first few times before putting the food out. They also learned to come in answer to my whistle. On the other hand their wariness was little affected. Once when I had to remove a long pole which leaned over their plot they did not come for quite a while. Why they ceased to come toward the last I do not know unless the stormy weather and snow which came at this time had something to do with it.

Method of Experimentation and Special Precautions.

The general method used was the one common in comparative psychology of requiring the hungry animal to overcome some simple difficulty in order to obtain food. In all the tests an attempt was made not only to get the time measure of the rate and the methods of learning employed, but also to get the number and character of efforts made in each trial. Since the sorts of efforts fell into fairly separate and distinct classes, the attempt has been in a measure successful.

The work on the English Sparrow took much more time than had been expected because of the difficulty of keeping the birds in good condition and yet having them hungry when my time would allow me to experiment with them. Animals generally spend a large part of their waking lives in seeking and eating

food, and since, in a general way, it is accepted that the vital processes in birds are very rapid, it was doubly necessary to guard against extreme hunger. To this end I hardly ever used a condition of hunger greater than would be caused by an over-night fast. Food was usually taken away at eight A. M. and tests were made an hour later, so that except when new experiments were being attempted they were rarely without food for more than two or three hours.

The food given them was a mixture of cracked wheat and corn, soaked bread, and recently bird seed of several different kinds. This, as will be seen from the government reports, is largely the kind of food which these birds eat naturally. They have been well supplied with sand and gravel. At first they were kept in a small basement room, poorly heated and ventilated, where the direct sunlight hardly ever reached them. But recently, and while making the major part of the experiments, they have had an attic room where they got the morning sun and where there was plenty of heat and fresh air. Usually, unless for control tests, the birds had been kept in a small cage for several days or weeks before they were put in the large cage (eight by four by seven feet in size), in which all the experiments were made. They had become pretty well accustomed to their surroundings before they were subjected to any tests.

The apparatus used in the study of the sparrow's methods of learning was a small box with one end and side covered with one-fourth inch wire netting. See Fig. 1. A hole three inches square was cut in the middle of the side covered with wire and a wire door made for this. The door was made heavier by doubling the wire and weighted at the top and the right hand corner, the hinges being on the left. The box was tilted forward slightly so that the door would swing open when the latch, which consisted of a thin strip of brass, had been lifted out of the catch. This catch was at first one-fourth of an inch in height. Food was placed in this small box and this set down in the centre of the large cage. Care was taken to habituate the birds to this small box by leaving the door open and allowing them to feed out of it for a few times. In fact, I found that when the box was put in with the door closed, the bird having never seen the box before, it did not succeed in opening the door in a reasonable length of time. But by allowing the bird to learn where the door is and then closing it, he, of course, had a more limited territory in which to work and soon hit upon the right thing.

In the tests the birds were free to enter the small testing box or not as they chose; there was no compulsion. The same was true of the experiments with the maze to be described

presently. This, I think is an important precaution with the English Sparrow and, in fact, with all birds. It is natural that they should feel confinement in small quarters, and the

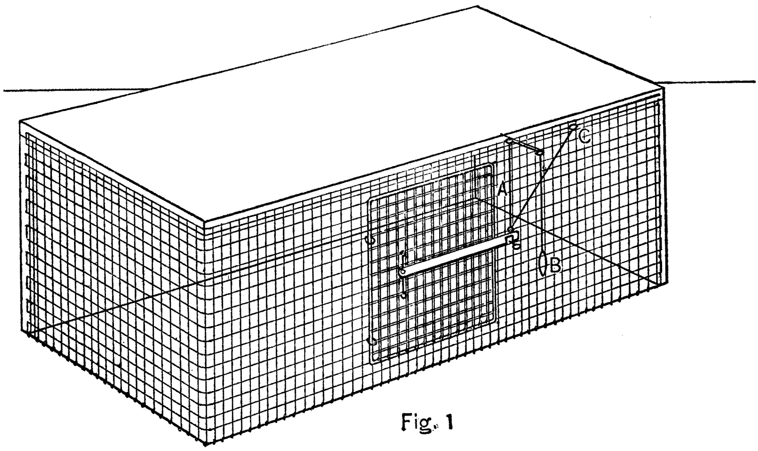

Fig. 1

Sparrow "while adapting himself readily to confinement never becomes reconciled to it." Morgan's exhortation to avoid cramped quarters and extreme hunger in experimenting with animals would seem to be especially applicable here.[1]

For the first series of experiments with the small box described above, a string was fastened to the latch, passed directly upward to a ring at the upper edge of the box, thence out along the wire arm, through a ring on the end of this arm and down some two and a half inches from the side of the cage and a little to the right of the door. See Fig. 1, A.B. A loop was tied in this string at the level of the bird's head. This string was used by the birds in the first series of the experiments only. As there was nothing to prevent them from pecking the latch this was done and this latter method was one used oftener than any other as will be seen in the description of each of the series to be given later.

In later experiments I have attached the string in another way, running it from the latch to a nail driven into the upper edge of the box. See Fig. 1 C. When the bird climbs over the side of the cage he pushes in the string and lifts the latch at its lower end. The door swingsopen as soon as the bird releases the string. One bird learned to push this string in with his head and later with his bill. The last bird, a female, learned to open the door by pushing up the latch, rather than by pecking it.

[1] C. Lloyd Morgan: Animal Behavior, pp. 149 and 151.

The following tables give the results obtained in the experiments described above:

SERIES I.

Exp.	Time.[1]	Sex.
1	6:	?
2	Failed	?
3	"	?
4	9:	?
5	2:	?
6	1:	Female
7	:30	"
8	:30	"
9	:25	"
10	:25	"
11	1:	Male
12	:20	Female
13	:10	"
14	:30	Male
15	:30	"

SERIES II.
(Female.)

Time.	No. of Trials.
3:	?
:45	10
—	3
:30	3
1:	30[2]
:15	6
1:	25
:30	18
:30	11
20:	98[3]
8:	91
3:30	73
:30	8
:25	13
:15	2

SERIES III.
(Female.)

	Time.	No. of Trials.
1	3 —	?
2	Failed	?
3	"	?
4	4:30	?
5	Failed	?
6	4:30	?
7	3:30	9
8	4:15	9
9	5:00	18
10	1:15	4
11	1:30	15
12	:45	4
13	1:15	4
14	:40	3
15	:30	4
16	:45	4
17	:12	6
18	:15	4
19	:05	2
20	:04	2
21	:20	6
22	:20	4
23	:04	2
24	:20	9
25	:25	8
26	1:20	12
27	1:00	1
28	:04	2
29	:15	3
30	:15	3
31	:07	4

[1] In all these tables the time is given in minutes and seconds.
[2] The fastening was made more difficult to work.
[3] The food was taken from immediately behind the latch and placed near the left end of the box.

Series IV. (Male.)			Series V. (Female.)		Series VI. (Male.)			Series VII. (Female.)	
No. of Exp.	Time.	No. of Trials.	Time.	No. of Trials.	No. of Exp.	Time.	No. of Trials.	Time.	No. of Trials.
1	10:50	?	Failed	?	1	Failed	?	4:30	?
2	10:30	8	"	?	2	"	?	1:04	?
3	2:08	5	20:00	?	3	10:10	8	:55	5
4	1:06	5	3:15	?	4	6:03	5	1:30	1
5	3:00	6	:45	8	5	:30	3	3:00	4
6	:50	5	:15	1	6	:03	1	:25	5
7	:40	3	:05	2	7	:16	3	:15	2
8	2:00	11	:30	12	8	:16	4	1:00	4
9	1:00	4			9	:03	1	:15	1
10	:12	1			10	:35	7	:15	2
11	1:20	7			11	:45	9	:04	2
12	1:00	7			12	:20	3	:37	10
13	:10	2			13	:10	1	:11	6
14	:09	1			14	:03	1	:10	5
15	:06	2			15	:15	2	:58	19
16	:04	1			16	:20	5	:59	8
17	:03	1			17	:35	3	:34	6
18	2:30	3			18	:02	2	:26	14
19	:15	3			19	:09	3	:17	6
20	:15	4			20	:30	8		
21	:15	4			21	:30	5		
22	:10	4			22	:50	2		
23	:12	4			23	:01	1		
24	:05	3			24	:04	1		
25	:04	1			25	:15	1		
26	:09	1-3			26	:04	1		
27	:09	0-4			27	:03	1		
28	:15	-5			28	:40	4		
29	:02	2			29	:40	5		
30	:06	1-3			30	:10	1		
31	:05	2			31	:01	1		
32	:03	1			32	:01	1		
33	:10	1			33	:05	1		
34	:30	1			34	:08	2		
35	:06	2			35	:09	3		
[1] 36	3:30	39			36	:02	2		
37	3:40	27			37	:01	2		
38	:05	3			38	:01	1		
39	6:45	21			39	:10	5		
40	1:12	11			40	:03	4		
41	:03	1			41	:02	2		
					42	:01	2		
					43	:02	2		
					44	:15	2		
					45	:06	1		
					46	:15	1		
					47	:02	1		
					48	:03	1		

[1] Here the string was taken off and he had to learn a new way to open the door. The string was replaced for trials 38 and 41.

Series I. As a rule the experiments in this series were made twice each day, once in the forenoon and once in the afternoon. There were five males and two females in the large cage when this experiment was begun. It was quite a while before I could tell certainly which one was opening the door. One of the females died just before the fourth test and the other female was the first to be recognized certainly as the one opening the door. But one of the males succeeds in the eleventh test and he does it in so short a time that it suggests previous experience or unparalleled imitation. He profits by it, too, for he opens the door very promptly in the fourteenth and fifteenth experiments. The female operated from the right side of the string and the male in much the same way from the left. I feel pretty certain that what he did in the eleventh trial was his first effort. Of the possibility of imitation I shall speak later. In this series the door was opened by catching the suspended string in the claws and pulling it in and down, thus lifting the latch. This required not a little skill as the bird must hop out from the upper edge of the box, turn partly round and catch the string in its claws. At the ninth test in this series there occurred the most skillful thing observed in the whole study. The female started from the perch in the large cage some five feet above and four feet away from the small box. She attempted to catch the string in her claws as she flew past the top of the box. But she struck the floor some three feet beyond, flew directly back, and this time succeeded in catching the string. In the seventh trial and most of the following trials of this series, there was wheat and corn on the floor outside the box to be opened; but as a rule the food inside had a greater attraction because it was made more conspicuous by placing soaked bread there in addition.

Series II. In this series the tests were made twice daily as in Series I. There were two birds, a male and a female, in the large cage. The male opened the door first in one minute by pecking the latch. However, the next time the female opened the door in the time given under 1 in the table, and continued to do so. In the table will be found the number of trials made as well as the time taken for the animal to get inside the box. In this table it will be seen that the number of trials in the fifth test increases suddenly from three to thirty. This was caused by fixing the latch. The change made it more difficult to raise the latter above the little wire catch. But this increased number is reduced in much the same way as is shown in all the trials. At the tenth experiment in this series, I happened to place the food, which was soaked bread in this case, near the end of the box covered with wire. This so attracted the bird away from the latch that, by counting the efforts made

alternately on the wire at the end and near the door, I succeeded in getting an experiment in Interference and the following quantitative expression for it:

No. of Exp.	Trials Near the Food.	Trials at the Latch.
1	87	11
2	13	
		9
	10	
		7
	11	
		4
	20	
		5
	4	
		3
3		6
	6	
		14
	12	
		8
	7	
		7
	5	
		8
4	0	8
5	0	13
6	0	2

Series III. Here the tests were made four times daily. There were three males and one female in the large cage. The female opened the door by pecking the latch. This table shows very clearly the effects of an over-night interval on the memory. It is seen both in the longer time and the greater number of trials in the ninth as compared with the eighth test, in the thirteenth as compared with the twelfth and in the twenty-first as compared with the twentieth.

Series IV. In this series the tests were usually made three times daily, twice in the forenoon and once in the afternoon. The suspended string as in Series I was used, but as the door was opened by pushing in on the part that extended from the latch to the upper edge of the box, the part that hung down from the wire arm was taken off. The string was tied to a nail and was just long enough to be taut when the latch was in the bottom of the groove made by the wire catch. Any push or pull would lift the latch and thus open the door. There were two males in the large cage at this time and I could distinguish them from the fact that one was brown and the other slightly gray. Brownie succeeded in opening the door first by pushing in the string with his claws. The changes made in his manner of opening the door and the rapid leaving off in the first few

tests of the unnecessary movements made this one of the most valuable of the series. At first he hopped up to the left of the door; on the far end covered with wire; walked along the front side with one foot on the floor and one on the side of the box; and climbed down over the sides from the top. He accidentally struck the right place and the detailed records written immediately after each experiment show that the unnecessary reactions get fewer in number with each successive experiment. In the tenth test he has left off all of them. At about this time he begins to use his bill on the string. Instead of pushing it in with his claws he strikes it with his bill. In the twenty-seventh test he does not cling to the side of the box while striking the string with his bill but pulls the string while standing on the floor. In the thirty-seventh trial the string is removed and he must learn a new way to get in. He does this by striking the latch with his bill and the table shows how rapidly he reduces the number of these and how nicely he is able to discriminate between the box with the string on and the same box without the string. This string was of a very dull color being the common very strong wrapping cord. But he did not seem to hesitate as to what to do and showed the same power of discrimination as the cats experimented with by Dr. Thorndike.

But this change in the method of learning was more valuable for its effect on the other male bird which was in the large cage with B. When the latter was hopping back and forth in the intervals between trials, the other male was following, pecking and running under him. And in the second of this new series he hopped up on the side of the cage much as B. had done. The next time he tried the same thing five times. It was also to be seen that he expected the door to open when B. hopped down after each trial, since he made ready to go in. He still ran under B. and pecked him in succeeding trials, but as B. learned to open the door in a shorter time, and the old fastening was used often, there was less opportunity for imitation. After the forty-first trial B. was found dead. When the box was set in the other male took the right position for opening the door three times. It should be noted that this position was not this bird's habitual way of approaching the box. He, in the beginning of this series, hopped to the top of the box and around it on the floor. Judging from these tests and those in Series I, it would seem probable that sparrows imitate, though just what the nature of this imitation is the data are insufficient to show. Additional experiments should be made in which there is a good opportunity for imitation. Such I think was the case in the above experiment in which the conditions were suddenly changed, but left the bird to be imitated present, with the necessity for the bird doing the imitating to do something as well.

I find that Mr. L. T. Hobhouse has laid down exactly similar conditions when he says: "Thus it would be more likely that one animal would imitate another if both were trying to escape or get food at the same time. Whether under these conditions there might be reflective imitation—imitation based on the perception of another's act and its result to that other—remains uncertain. What has first to be settled is the possibility of a still simpler mutual act—learning by the perception of an event and its consequence—when that consequence directly affects the learner. If an animal sees something done which has the immediate effect of giving it what it wants, then the something done falls within the sphere of interest as above defined. . . . But if (an animal pulls a string) because he has seen it pulled . . . his act appears rather as a practical application of what he has seen. . . . It is quite possible that an animal should get to this point without being capable of the slightly more complex act of applying to himself what another does on his own account."[1]

If imitation is to be found anywhere in animals it seems that the gregarious, quarrelsome, and pugnacious English Sparrow would be one in which we should expect to find it. From the time when the young are able to take care of themselves they go in flocks more or less by themselves. When mating time is over the old ones join these and, as we all know, the English Sparrow is rarely seen alone. The cry of one of his own or another species, as I have often observed, is sufficient to bring all the sparrows within hearing to the spot at once. Such conditions promise much if we can but suit the expeiiment to the distinctive movement of the animal.

Series V. This series is a short one but has the advantage of being made on a female bird just caught. The tests were made twice daily. In the third trial she opened the door by falling against the string. She made no use whatever of this incident, but opened the door the next time by striking the latch with her bill. This lack of power to profit by results which do not follow immediately from definitely directed efforts has often been noticed in these experiments. This would suggest, probably, that the range of attention in this bird is narrow. The results which fall within this range are readily associated as all the tests go to show. But a result which is removed from the efforts of the animal in either space, time, or otherwise, it does not seem to be able to use with much, if any, profit. The closing records of this bird, as a good many of the others, show the longer time and the greater number of trials caused by an abnormal condition. On the day before the last I was

[1] Hobhouse: Mind in Evolution, pp. 149-151.

almost certain that she would be found dead the next day, and such was the case.

Series VI. Here the experiments were made twice a day until the eleventh trial, and once a day after that. A male and female were in the large cage but the female was removed after the third trial. The male opened the door by pulling the string with his bill. He is the first male to succeed in first learning the thing to be done when there was a female present. Between the twenty-fourth and twenty-fifth trials there was an interval of eight days. In the meantime the bird was caught and the cage moved to another building. The fifteen seconds in the twenty-fifth trial also includes the time which the bird took to pick a grain of wheat out from inside the wire. He really used but little more time than in the preceding trial and he needed to make but one more effort. This only indicates that the Sparrow has a good memory, as later experiments will show also. This series was longer than the others, the tests here being carried on while the color and number tests were being made. These tests often preceded the opening of the food box by only a few minutes. Often there was food on the floor outside the box. Thus we see that a condition of intense hunger is not necessary in the making of these experiments. A few times I tapped my foot on the floor or otherwise started the bird toward the box, after which he continued his chain of reactions and opened the door.

In this connection Mr. Frank C. Bostok's description of the learning of wild animals seems timely. He says: "An animal learns by association. Though it is a common belief, fear is not the reason for his obedience to the trainer's commands. Habit and ignorance are what cause the animal to become an apt pupil in the hands of the trainer. The animal becomes accustomed to the same way of doing the same things at much the same time, and ignorance of his own power keeps him in this state of subjection.

"This habit is developed in the animal by a laborious and patient process. . . No animal is ever allowed to backslide. . . Such is the force of habit that laxity to-day means a desire for laxity to-morrow. . . ." And further Mr. Bostok shows the remarkable force of habit in a lion which, having thrown him down and carried him over to the other trainer was made to let go his hold and forget his anger by the firing of two pistol shots and the trainer throwing his arm around the lion's neck. These were the signals for a change in the regular performance and it worked here through the sheer force of habit, though in quite different conditions.[1]

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[1] The Training of Wild Animals, pp. 120, 152, 158 and 159.

The first part of Series VI, perhaps, shows the effect of an over-night interval.

Series VII. A female bird was placed in the large cage by herself and tests were made once each day. She first opened the door by lifting the latch with her claws. The door did not swing far open and she had to push it with her bill. Although she used her claws in the second and third trial, in the fourth trial she used the more direct method of pushing the latch up with her bill. This shows clearly that with identical apparatus each bird has its individual way of doing the same thing. After the tenth test I made the catch longer so that she must lift the latch one half inch instead of only a quarter. This did not seem to trouble her the next time; but after that it seemed to do so. She struck the latch now instead of pushing it up.

The following are some of the conclusions concerning the methods of learning of the English Sparrow: first

(1) The rate of learning is *at first* very rapid.

(2) The great decrease in amount of time required consists largely in locating the part to be worked upon and therefore in the leaving off of unnecessary movements.

(3) Later the gain in time is due to making the necessary movements more rapidly and accurately.

(4) The first opening of the door is due to happy accident; the bird often not being aware at the time of what it has done.

(5) There is no sign of reason in the sense of looking forward and of adapting means to an end. But there is certain proof of a very great ability to profit by experience and some evidence of an ability to profit by the experience of others, as shown in imitation.

(6) The habit of getting into the box is very soon formed and once formed is very masterful. As early as the sixth trial there may be food on the floor around the box and yet the bird neglects that and makes the required movement for getting at what is within.

(7) Its habits are nevertheless still plastic and change readily to fit new and changed conditions. It not only readily adapts itself to changes made by the experimenter; but perfects its own adjustments by dropping off what is unnecessary.

(8) The individual differences are very well marked in all the experiments.

The curves below, Figs. 2, 3, and 4, represent the times which were given in three of the foregoing tables, Fig. 2 corresponding to Series III, Fig. 3 to Series IV, and Fig. 4 to Series VI. It was thought unnecessary to represent the shorter tables by curves since they exhibit nothing which is not true of the longer ones. The distances on the ordinates represent time in seconds, and the successive trials are in-

dicated on the abscissa. It should be noted, however, that in Figs. 2 and 4 the first trial in each is really the sixth and

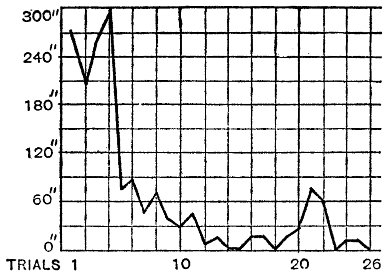

Fig. 2

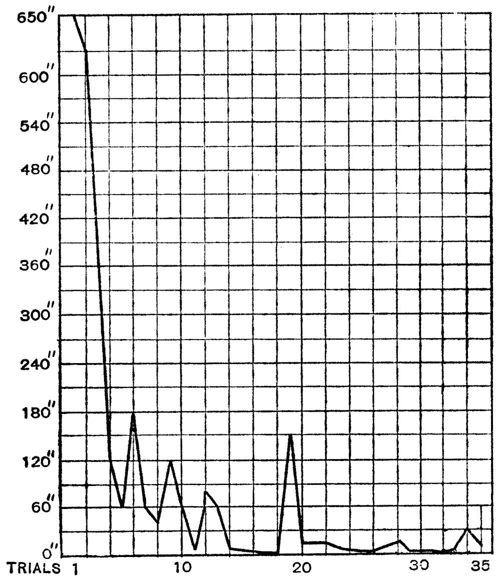

Fig. 3

second in their respective series. If these curves are compared with those of Drs. Thorndike[1] and Kinnaman[2] for the higher animals, including monkeys, although the conditions were not identical, it will be seen that there is a striking similarity in

[1] Edward L. Thorndike: The Mental Life of Monkeys. Psych. Rev. Monograph Supplement, Vol. III, No. 5, p. 11; also Animal Intelligence, Psych. Rev. Monograph Supplement Vol. II, No. 8, pp. 18-36.
[2] A. J. Kinnaman: Mental Life of Two Macacus Rhesus Monkeys in Captivity. *Am. Jour. of Psychology*, Vol. XIII, p. 117.

form. It is necessary that the fastenings used for the birds be very simple. The limitations of the animal's structure will not

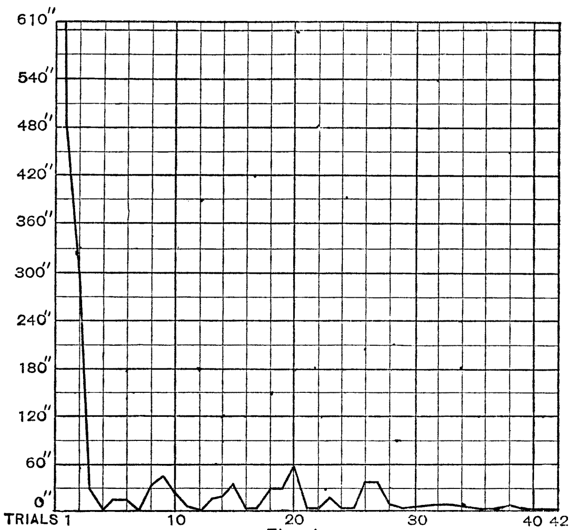

Fig. 4

allow them to be otherwise. Yet the manner of pulling the string in Series I suggests that something more complex and calling for greater nicety of co-ordination would be possible if one should take the time and trouble to work it out. However, the rate at which the "number of efforts" is reduced, as shown in the above tables, is very significant. An animal's "power to profit by experience" is, after all, the best criterion by which to judge of its intelligence. A very stupid animal, if he had a human-like hand would very probably be classed by many as very intelligent. Therefore it seems to me that any animal showing the power of inhibition which is seen in this bird must not be ranked low in the scale of mental capacity simply because of our inability to match its structure and movements with our artificial experiments.

So-called Number Tests.

The attempt made here was to study in the same way as Dr. Kinnaman did with his two monkeys[1] the number sense of the English Sparrow. Ordinary glasses were covered with dark gray paper, of a shade that I found from preliminary tests that the birds were probably the least afraid of. These glasses were placed in holes two and one-half inches apart and large enough

[1] Kinnaman: *op. cit.*, p. 173.

to allow the glasses to extend through the lower edge of the board. The board was three feet and ten inches in length, five inches wide and one inch thick. It was held up off the floor by two cross pieces two inches high. As the glasses expand toward the top there was a distance of only two inches between their upper edges. See Fig. 5.[1]

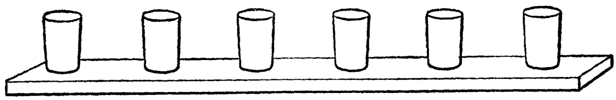

Fig. 5.

About 1,900 experiments each were tried with one male and one female. The male Sparrow was experimented with first, and for him the food was placed in glasses in the following order: 3, 4, 2, 5, 1, and 3 again. The order for the female was 3, 4, 2, 5, 2, 1. When I began these number tests the large cage had but one door and I could use but one end of the cage; but only a few of the first series of experiments were made in this way as I very soon had a second door put in. After this was done I could enter the large cage at one end, pick up the board, carry it to the other end, place it across the large cage anywhere from near the middle to near the end and leave by the door at that end. This kept the bird at the far end of the cage until I could get behind the screen. The food glass was alternately on the bird's right and on his left as he made successive trials from different ends of the cage. A newly papered food glass was substituted often and irregularly, the glasses next to it were changed frequently, and the board turned round; but no change of this kind ever made any difference that I could notice with the birds' selection. Whether the right glass was chosen or not, the birds were allowed to take one bit of food. The experiment of making them do without when they did not alight on the right one was tried, but this only made them miss the more.

The following tables give the results of these tests, the number of correct choices being underscored and the results of each successive series of twenty tests extending from left to right above this line.

The record was kept on a paper ruled into squares corresponding in relative position with the glasses. The glass on which they first alighted was marked a, the next they went to b, etc. I thus obtained not only a record of their selections but also of their sense of direction and position and in some few ex-

[1] This was so nearly like Dr. Kinnaman's apparatus for his color tests that I have here, with his consent, reproduced his figure, though I used ten glasses.

Male.

No. of Glasses.	Food in Three.									Food in Four.													
1																							
2	4		5	12	8	1		1	3	1	2												
3	2	7	8	15	12	6	9	14	16	3	2	3	4	3	3	1	1	1	1	2	2	2	1
4	11	6	1	3	7	17	9	5	9	3	5	6	7	10	7	9	7	9	11	8	7	8	13
5	5	5			2	5	2		2	6	4	8	6	5	10	5	8	5	6	9	9	6	6
6	1	2								3	4	3	1	2	2	5	4	5	2	1	2	4	
7										4	2	1	1										
8											2												
9																							
10																							

No. of Glasses.	Food in Two.																
1			1		2	1	2	1	1		1					7	4
2	4	6	6	12	14	17	12	11	12	13	18	13	15	16	13	12	14
3	6	8	3	6	1	2	5	5	4	2		2	6	3	5	1	1
4	5	7	3	2	2				2	2		4	1	3			1
5	4				1		1	2	1	3	1						
6	1		1					1									
7												1					
8																	
9																	
10																	

No. of Glasses.	Food in Five.																		
1			1				1												
2	6	3	2	3		2	3	1											
3	6	4	8	6	1	3	3	1				2							
4	2	7	1	1	7	2	6	5	5	3	6	5	9	4	5	6	6	5	4
5	2	3	2	2	8	7	6	8	12	12	9	8	8	13	13	13	7	11	12
6	4	2	4	7	4	2	1	5	2	4	4	4	3	3	2	1	6	1	3
7		1	2	1		4			1	1	1	1					1		0
8																			1
9																			
10																			

Male.

No. of Glasses.	Food in Three.									Food in One.							
1										6	9	11	6	5	9	9	9
2			2				3	3	1	7	8	7	9	5	7	9	7
3	0	2	1	4	4	10	6	9	15	6	3	1	3	6	2	2	4
4	7	10	11	13	14	8	6	8	3	1		1	1	3	1		
5	11	6	6	2	2	1	3		1						1		
6	2	2		1		1							1	1	1		
7							1										
8							2										
9																	
10																	

Female.

No. of Glasses.	Food in Three.																
1																	
2	1	1	2	3	3	10	11	1	8	6	1		2	3	4	2	3
3	5	3	9	3	7	10	7	16	9	12	13	12	7	6	5	10	7
4	5	6	7	10	10		1	3	3	2	5	6	9	8	7	7	8
5	4	5	1	2			1				1	2	2	2	4	1	2
6	2	2	1	1													
7	3	1															
8				1													
9		1															
10		1															

No. of Glasses.	Food in Four.																
1			1														
2	5																
3	1	6	6	3	3	3			4	3	2	3	1	1			
4	11	8	10	5	6	4	7	8	8	10	7	8	11	12	9	12	12
5	1	6		9	7	6	11	11	6	6	7	7	6	6	6	8	5
6	1			3	3	5	2	1	1		4	2	2	1	5		3
7	1		3		1	1			1								
8						1											
9																	
10																	

No. of Glasses.	Food in Two.									
1							1	1		
2	0	4	2	1	0	6	3	4	3	8
3	3	5	7	9	5	5	7	5	7	4
4	9	5	6	8	7	8	6	9	8	5
5	2	2	1	2	4	1	3	1		3
6	5	1	4		4					
7	1									
8										
9										
10										

No. of Glasses.	Food in Five.																				
1																					
2																					
3	2	2	2	1	2						1	1	1					1			
4	4	5	5	4	4	2	6		5	5	6	5	10	8	8	2	7	6	8	5	7
5	2	7	4	4	8	9	9	11	6	11	11	9	2	5	6	11	7	5	7	12	10
6	4	4	4	6	5	6	5	8	9	4	2	5	7	7	6	7	5	7	5	3	3
7	5	0	4	5	1	3		1									1	1			
8	2	2	1																		
9	1																				
10																					

No, of Glasses.	Food in Two.																
1													[1] 1	8	4	8	3
2	0	0	3	7	4	5	6	8	3	7	6	8	13	10	13	9	15
3	0	7	5	4	5	7	9	7	7	1	9	6	6	1	3	3	2
4	9	7	4	9	6	8	4	4	10	8	5	5					
5	10	5	5		5		1	1		3		1					
6	1	1	1							0							
7			2							1							
8																	
9																	
10																	

No, of Glasses.	Food in One.									
1	0	1	1	6	8	7	7	8	7	[2] 15
2	0	7	7	4	5	5	3	2	5	5
3	3	4	6	9	7	8	9	8	8	
4	13	5	3	1			1	2		
5	3	3	3							
6	1									
7										
8										
9										
10										

periments with one of them, of their sense of distance as well.

In experiments of this kind it is very important that after the sparrows have learned to feed from one glass, they should not at once be tested with another. Since in that case the older association interferes with the formation of the new. This interference when the series follow each other immediately is evident in the tables above. In the table for the male Four does not show the effect of preceding experiments with Three because there was a rest of some weeks intervening. But Two shows the effect of Four, Five of Two, Three the second time of Five, and one of Three. It will be noticed that with some of these the interference is greater than with others; but for this no reason can now be given. The female showed the same difficulty in breaking away from Four and Five for Two. Judging from both observation and results, I believe that the habit which the sparrow has of alighting some distance from

[1] Here the two end glasses were taken away, the food glass occupying second place still but where four was originally.

[2] Here the food glass was put in the fourth place but still first in the series.

his food makes it difficult by this method of experimentation to get a perfect expression for his ability to sense position in a series. Yet it will be seen by comparing these tables with Dr. Kinnaman's[1] that the birds begin with as high an initial number of correct choices, that with some of the locations they reach the maximum as soon, and that the percentage of correct choices is in many cases greater than for the monkeys. It should be added, however, that the birds were experimented on in smaller quarters than the monkeys and so had some greater opportunity to fix the position of the glass absolutely by associating it with the definite part of the cage. Yet the board was moved endwise and toward and away sufficiently far I think, to prevent any very constant association with a definite position in the cage.

The results show very few effects of the over-night interval, especially after the experiment was well started.

The records show another element which must be considered in interpreting these results. Usually the male bird flew from his perch, which was about eight inches long and at the middle of the farther end of the large cage at a height of about six feet. In fact, I took off the perches which extended the entire length and width of the cage to make him start more nearly from the same place each time. Yet he did not always use these small perches and by keeping a record of the position from which he started I was able to find some relation between his starting point and the glass selected. If, for example, he flew from the upper left hand corner of the cage he nearly always went too far to the right and *vice versa*. Again, if he walked instead of flying he had to get his bearings anew and often made errors. The manner in which both male and female made ready to single out the food glass was a repeated turning of the head in such a way as to run now one eye and then the other along the row of glasses. The male did this a good deal more than the female and I account for his better results largely through this. He was very deliberate, turning his head often as many as ten or twelve times before making his choice. The female was wilder, more impulsive and hence less accurate.

The place of the food glass in the row of glasses must be the thing which is sensed, since when the series were considerably shortened at one end (the food glass remaining second in the series, but standing much nearer the middle of the cage), the female lacked but one of doing as well as with the full series in which she had been practiced. The same change with *One* made no difference at all in the number of correct choices.

It might be added that the male did not do so well with food

[1] Kinnaman: *op. cit.*, p. 177.

in glass number *One* as with the others. Very early in the experiments with food in glass *One* he could get it almost every time when the board was at one end of the large cage and he seems to have simply preferred to alight on *Two* or *Three* and then hop to *One*. He knew where *One* was and often jumped over *Two* to reach *One*. A reason for this failure to fly directly to *One* may be the fact that it being on the end of the board was too near the side of the cage.

Another source of error was created by getting the bird too hungry. He would fly for the food before I was out of sight; and while he was not wild, my having to leave the cage at the corner and still being where he could see me, caused him to swerve too far to one side. This I tried to overcome by driving him back to his perch at once before he reached the food and not counting that time.

Finally, it may very well be asked whether all of these experiments come any nearer to proving that animals (birds in this case) actually count, or "perceive the relations necessary for counting." The method of experimentation does not require anything more than the location of the member of a series or the sensing of the size of a group. If we do not find in birds the power to count we have in their nice sense for the location of a member of a series or for the size of a group something of that preliminary number sense which Ribot describes as belonging to children and savages.[1] As we shall see the sparrow develops in a short time a very strong attachment for place and it is to be expected that this would help him materially here.

It was said above that the method of recording the results in these number tests made it possible to get a record of the birds' sense of direction. The errors in direction such, for example, as going to the left from the food glass when already too far to the left, or going to the right when too far to the right, were as follows: for the female 38 times in 1,840 tests, and for the male 23 in 1,360.

If each series of 20 tests is divided into four groups of five each, the mistakes of the female are distributed as follows:

First five, 42%; second five, 22%; third five, 19%; and the fourth five, 17%; of the male first five, 61%; second five, 8%; third five, 19%; fourth five, 12%. Although there was an average of *fifteen* series of twenty each for each number for the female and *thirteen and three-fifths* series for the male, 34% of the errors in direction for the female and 26% for the male fall in the first series of twenty tests. I give these results simply to show how early in each series, and in the work with each

[1] Ribot: Evolution of General Ideas, p. 35 ff.

number, the birds learned which way to turn in case they did not alight on the glass with the food in it.

Form Tests.

No form tests have been made on the male, and with the female they followed immediately the tests with the food glass in the third place.

The forms were six in number and the size of each was as follows: Hexagonal, 1⅔ inches on each side; triangular, 4⅜ inches; elliptical, 4½ x 2⅜ inches; circular, 3¾ inches in diameter; rectangular, 3½ x 2½ inches; and the square, 2 15-16 inches. See Fig. 6.

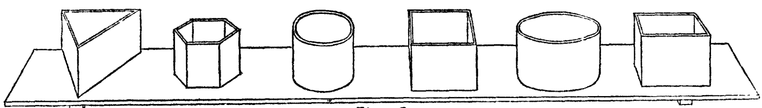

Fig. 6

In this respect they were different from the forms used by Dr. Kinnaman with the monkeys as his forms were of different heights as well.[1] These forms used with the birds all have approximately the same capacity. They were made by gluing the one inch poplar boards together and sawing out the box the shape desired in one piece, one-eighth of an inch thick. The bottoms were then fastened in with glue and all were stained black.

The board on which I placed the boxes was the same as that used in the number tests. The food was first placed in the triangular box and kept in this through the whole of the test though the box itself was shifted after each trial to a different place on the board, the place being determined by a programme previously made out. Not only was this food box changed, but the box which the bird alighted on first in each trial was changed also. It was early seen that she could not or did not distinguish the triangular box from the rest and it was thought worth while to see if she would follow the box she alighted on first. Each series consisted of twenty tests. The different forms were tried in the order given in the following table.

It is evident from the results given in the tables below that she showed very little power to distinguish form. She alighted on the 2nd, 3rd, and 4th box from the end of the series, and it made very little difference what the form was. She very rarely followed the food box or any other to a position next to the place it had occupied in the preceding experiment. She succeeded in picking out the right form only when it came to the positions where she was in the habit of alighting, and often she changed

[1] Kinnaman : *op. cit.*, p. 129.

Form Tests. Female Bird.

Box Chosen.	Triangular Box contained food.														Total.
Cir.	1	4	5	3	3	5	6	1	3	4	4	4	3	6	3—55
Sq.	1	1	4	4	3	3	1	4	3	3	3	3	3	1	3—40
Tri.	4	2	2	3	4	2	4	5	4	4	3	5	5	5	3—55
Rect.	5	2	3	2	2	5	2	3	3	2	4	3	2	2	5—45
Hex.	6	5	4	3	5	1	3	4	3	2	3	3	4	1	4—51
Ellip.	3	6	2	5	3	4	3	3	4	5	3	2	3	5	2—53

Box Chosen.	Elliptical Box contained food.								Total.	Rectangular Box contained food.										Total.
Cir.	3	3	2	2	2	4	2	5	3—26	3	4	3	3	3	4	3	3	3	3	3—35
Sq.	2	3	4	3	5	3	4	3	2—29	4	3	4	3	4	4	4	5	3	4	3—42
Tri.	3	4	4	3	3	3	2	3	5—30	3	4	3	3	3	3	4	3	4	2	5—37
Rect.	5	2	3	5	3	3	3	3	2—28	4	6	5	3	3	3	4	4	4	4	4—44
Hex.	4	1	3	4	4	3	2	2	2—25	4	2	2	4	3	3	2	3	3	3	2—31
Ellip.	3	6	4	3	3	4	7	4	6—40	2	1	3	4	4	3	3	2	3	4	3—32

Box Chosen.	Circular Box contained food.								Total.
Cir.	4	5	4	4	4	3	3	4	7—38
Sq.	4	3	5	3	4	3	4	3	3—32
Tri.	2	3	2	3	3	4	3	3	3—26
Rect.	2	3	4	3	3	2	4	3	3—27
Hex.	4	3	3	3	3	3	3	3	1—26
Ellip.	4	3	2	4	3	4	3	4	3—30

from the 3rd to the 4th, or *vice versa*, just in time to miss the right box. Her alighting on the third box first falls into groups as her correct choices in the number tests very often did. The records show that when the form tests were first begun she showed a decided place preference for 2 and 3. This gradually gave way to 3 and 4 and the closing tests show that she had begun on 4 and 5. If she alighted on the third box and found the food-box to her right at 1 she usually turned to the right the next time although the food-box was now to her left at 5. She either did not distinguish or notice the forms, or her associations with place were so firmly fixed that she did not overcome them.

Color Tests.

From the brilliancy and variation in the coloration of birds and from Dr. Thorndike's[1] work on young chicks, perhaps we can rightly infer that birds possess considerable power of color discrimination. It was to obtain some idea of how far this is true of mature birds that the present experiments were made.

The first experiments on color with the Sparrows were de-

[1] Thorndike: The Instinctive Reactions of Young Chicks, Psych. Rev., Vol. VI, pp. 282-291.

signed to show their color preferences. Six shallow dishes some five inches across were covered with the following colored papers—white, yellow, gray, blue, red, dark gray and green. The blue was lighter than the standard blue of the Bradley colors and the green darker than the standard green. There were two birds in the cage during the first series of experiments of this kind and one followed the other most of the time. With both, place seemed to be the determining factor as out of 125 experiments, although the dishes were shifted each time, the bird leading went to the third from the end 54 times, the fourth 48 times, the second 19 times, leaving out the first, fifth, sixth and seventh almost entirely. They showed least fear of the grays and most of the green and yellow. But the fact that stands out here is the strong hold which place has upon them. The bird which followed showed more fear and therefore more choice and when experimented on alone he showed the same preference for place and also a slightly greater preference for the grays, but was rather easily induced to eat from the green dish.

The above experiments were merely preliminary. The experiments proper were made only on the female. These followed immediately after the tests with the same bird on the forms. The same board was used as for the number tests and six of the glasses were covered with the Bradley colored papers —a dark gray, a light gray, a bright yellow, a dark blue, a light green and a dark red. The brightness has not been experimentally determined.

A programme made out previously determined the place of the food-glass as before. Twenty tests were made in each series. The following table gives the result, the colors being tried in the order given:

Female.

Colors.	Food in Blue.					Food in Yellow.										Food in Red.					
Blue,	12	14	13	12	19	16	10	12	14	9		6	3	2		6	6	2	3	1	
Red,	1			1		1										2	1	9	15	14	20
Green,		2	2				2				1		1							1	
Yellow,			2	2			5	1	5	8	16	11	13	18	19	12	9	4	2	1	
Light Gray,	4		3	2	1	2	2	3	1		2	2			1		1	4		1	
Dark Gray,	4	4		3		1	1	4		3	1	1	3				3	1		2	

Colors.	Food in Green.				
Blue,	1	1	1	2	1
Red,	3		2		1
Green,	9	17	15	14	18
Yellow,	2			2	
Light Gray,		1		1	
Dark Gray,	5	1	2	1	

These results show that the female Sparrow can readily distinguish the colors used. She does quite as well as the female monkey tried by Dr. Kinnaman[1] for blue and green. She did not do so well for red and yellow. This may be partly explained from the fact that she was more afraid of these. Several times during these experiments she manifested the same thing which we notice so often in our own actions after they have been reduced to habit and changes in conditions call for a change in the order of reactions. She would fly to the blue glass and then go directly to yellow, jumping over several others. At the same time she seemed to show surprise at the fact that she had not alighted on the right one. This, of course, was after the color had been experimented with for some time.

Experiments with the Maze.

The maze was made after the plan given by Dr. Small, by whose permission I reproduce it here. See Figure 7, page 340.[2] It was, however, reduced to one-half the size, 3x4 feet. The alleys were made three inches wide and the partitions four inches in height. No pieces of wood were used to support the corners, but the edges of the strips of wire, one-fourth inch mesh, were unraveled and these unraveled wires run through holes in the wood bottom and clinched. At the top and sides the unraveled ends were clinched to the wire mesh. This gave a maze throughout of the same colored wire and of course very free from landmarks. This test is quite likely to be judged as a very artificial one for birds and one that does not call for the exercise of any one of their instinctive or habitual methods of reaction. Yet these birds work their way through the foliage of trees, through the leaves and plants which cover the ground and through crevices and drain-pipes in and about buildings. But granting that the test is an arbitrary one, success in it argues all the more for the intelligence of the Sparrow as we shall see from the results.[3]

The maze was placed in the large cage with food in the centre, which was covered with a wire lid. The bird, of course, came down and spent a good deal of time hopping round on, and pecking through, this lid. At the opening *o* Fig. 7, I had a door of wire which could be closed by a rubber band and

[1] Kinnaman: *op. cit.*, p. 136.

[2] Small: Experimental Study of Mental Processes of the Rat, II, *Am. Jour. Psych.*, Vol. XII, p. 207.

[3] In the cages with bottoms covered with paper it was a great surprise to me to see them crawl round under the paper in search of food, and one has to force them out as he would a mouse when they remain hidden and very quiet under the paper.

which I held open, until the bird had entered, by pulling on a

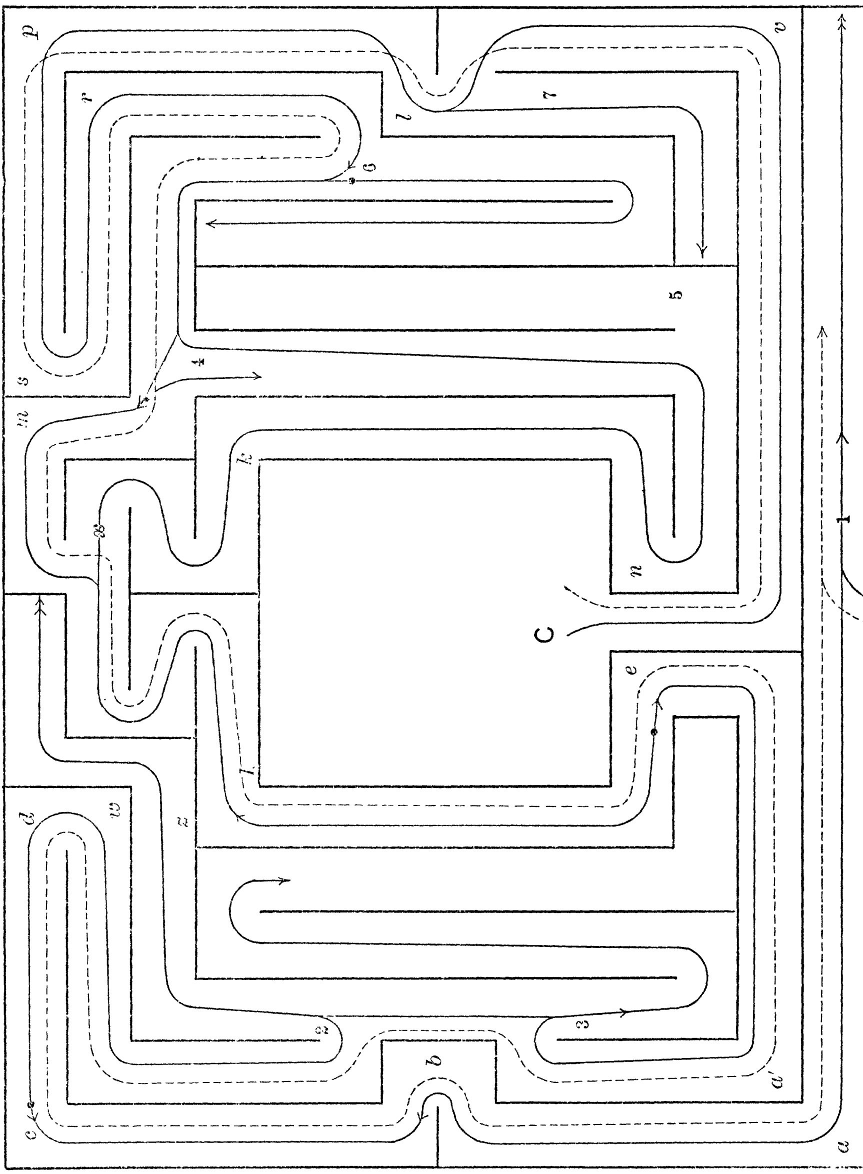

Fig. 7.

strong thread attached to the door and passing through the wire side of the large cage. The loosening of the thread and

allowing this door to close after the bird had entered and the pulling up of the lid over C after the bird had reached the food, nearly always caused some fright and perhaps was in so far objectionable.

In the first experiments I placed a few grains of food just inside *o* to induce the birds to enter. But after their first experience they evidently regarded the maze as a trap, and I have waited sometimes for hours until the bird's hunger should overcome his wariness. I should expect to find such wariness, such inhibition and control, in very few, if any, other birds. This does not mean that the Sparrows did not try the maze to see what it would do. They nearly always in their approach to any new and strange object have the appearance of testing it. They climb down the side of the cage toward the fearful object, fly directly toward it but hover and then away. If they walk toward it, they do not go directly. Their fear is not a senseless one. Some recent comparative experiments would seem to indicate that in some other wild birds *wariness* is less developed.

The time for passing through the maze was taken with a stop-watch as in the tests with the food-box and the number of errors was kept by use of the letters shown in Figure 7. The tests were made once each day and the maze removed from the large cage after each trial. I have succeeded in making tests on one female for seventy-one sucessive days. Also a series of twelve daily trials with another female and nine and six respectively with two males. The general reactions of all the birds toward the maze were pretty much the same. I account for the shorter time with one female by the fact that the others were less habituated to experiment and were much wilder than she was. In fact one of the males was tried with the maze only two days after being captured and he had a broken wing in addition. As will be seen from the table below I succeeded in making only six tests with him and yet he shows the same reduction of time and number of errors as the others. But the wilder birds struggled more to get out of the maze than to get to the food in the centre and were somewhat hindered by their efforts. The same struggling to get out was very pronounced in wild birds tried later with the larger maze which Dr. Small used. His white rats made better records, very probably because they did not spend so much time in trying to get out. The table gives results for the first ten trials with the Sparrows and also for one of Dr. Small's[1] white rats and both of Dr. Kinnaman's monkey's.[2] The numbers represent seconds.

White rat	780	180	240	105	60	90	180	30	60	120
Male monkey,	2700	1800	420	180	900	230	390	285	160	204

[1] Small: *Am. Jour. Psych.*, Vol. XII, pp. 214-218.
[2] *Op. cit.*, p. 187.

Female monkey,	3300	7920	840	420	375	450	210	195	165	135
Male sparrow,	3586	1635	893	1424	1072	729				
" "	2502	1697	374	665	72	67	365	210	169	
Female "	3186	457	768	701	326	155	104	72	330	256
" "	810	1305	850	150	70	340	319	140	435	540

The above table shows that the Sparrows are quite as rapid in learning the maze (that is, make as great gain proportionally) as the rats and monkeys. The graphic presentation which follows, Figure 8, shows this somewhat more clearly. The curves are obtained by letting the first times stand for 100 per cent. and computing the succeeding trials in terms of this. One space on the ordinate represents 12½ per cent.; the abscissa shows the successive trials. Only the first ten trials are represented. Curve 1 represents the rate of learning of one white rat, curve 2 the average of the two monkeys and curve 3 the average for three of the Sparrows, one male and the two females. The male Sparrow with only six trials to his credit has been left out of this average. Considered in this proportional way the birds are but little inferior, if at all, to the rats and monkeys; though on the other hand it must not be forgotten that the absolute distance which they had to travel was considerably less. It must be remembered that Dr. Small allowed his rat to spend the night following each trial in the maze and Dr. Kinnaman's trials came one after the other, while the Sparrows were tested but once in every twenty-four hours. Yet, again, judging from the effect of an over-night interval on the birds in the experiments with the food-box, it seems probable that if tried one trial after the other they would have done much better.

In counting the number of errors I included as mistakes the running back and forth in the blind alley marked 3 (and others as well) and have made them have the same standing as to enter 3 and follow it to its end. This, of course, charges the Sparrows with a great many errors which were not charged up against the monkeys at all. So no comparison can be made on the basis of the actual number of errors. Computing the percentages of the errors for the first nine trials, using the first as 100 per cent. and averaging the results for the two monkeys and those for the same three birds used in the curves above, we get the following table:

Sparrows,	100	75	35	27	23	18	15	6
Monkeys,	100	110	245	18	36	12	20	16

Also by using Dr. Kinnaman's[1] table for the averages for both times and errors in groups of ten consecutive trials for the monkeys, and treating my own results in the same way, the following table is obtained:

[1] Kinnaman: *op. cit.* p. 185.

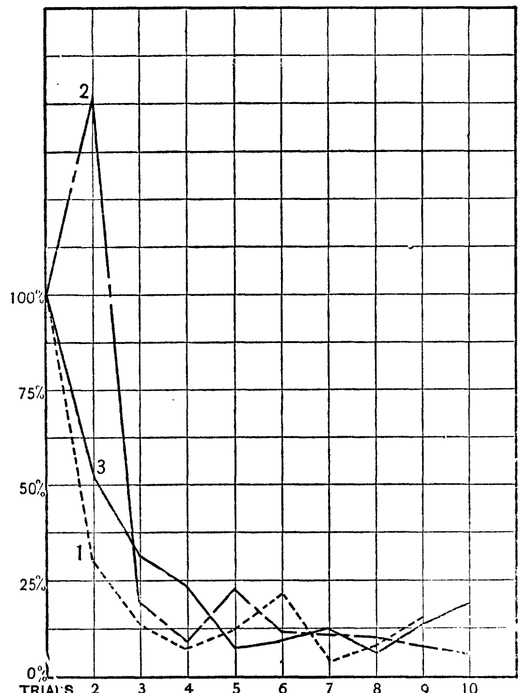

Fig. 8

Average Times in Seconds.

	1st-10.	2nd-10.	3rd-10.	4th-10.	5th-10.	6th-10.
Male Monkey	726.9	73.7	76.	64.4	61.2	67.2
Female Monkey,	2579	127.7	63.6	68.1	55.8	55.
Female Sparrow,	495.9	376.3	48.2	81.4	55.4	33.7[1]

Average Errors.

Male Monkey,	18.5	3.1	3.2	2.2	1.4	2.6	1.5
Female Monkey,	14.1	1.3	1.7	.7	.4	.3	
Female Sparrow,	63.9	46.7	1.8	9.2	4.2	1.8	1.3[2]

These tables show in the same way as the tables and the curves above that the Sparrows are quite as intelligent as the monkeys, if ability to profit by experience is taken as a criterion.

The female Sparrow with which I was able to experiment so long went through the maze without a single error on the 23rd

[1] The average of the 1st-10 trials with another female Sparrow is 635.5 seconds; the averages of the 1st-9 and 1st-6 with two males are respectively 680.1 and 1,553.5 seconds.

[2] The average number of errors for the 1st-10 trials with same female Sparrow is 99.1; the averages for the two males are for the 1st-9 and 1st-6 respectively 62.3 and 95.8.

and 24th trials; also on the 27th, 37th, 41st, 44th, 53rd, 56th, 57th, 60th, 64th, 65th, 66th, 67th, 70th, and 71st. The first time of going through perfectly falls midway between that for the monkeys; the male monkey going through without an error on the 36th trial and the female on the 13th.

The English Sparrow never ceases in his efforts to get through or out of the maze. He seldom stops to preen his feathers or to sit down and rest. He is persistency itself. This agrees well with his popular reputation and it certainly seems to me now that the English Sparrow owes much of his biological success to this strenuous characteristic.

The detailed records show that the sparrows with relative ease avoided blind alleys 1, 2, 5, and 7. They get caught at 3 *h-e*, *xkn*, 4 and 6. At first they spend a good deal of time between *he*, *n-k*, and in 3, by trying to get directly to the food. Alley 6 is rather difficult to avoid. They very often check themselves after entering a little way into 3 or any other blind alley. Two of them quickened their pace very perceptibly when about to reach 6 and at the same time were seen to raise themselves more erect and glance toward the entrance to C.

The birds often avoided entering any blind alley as far as 4 or 6 and, if when coming out of these they returned beyond the entrance to 2,3, or any other, they very often entered blind alleys which they had just avoided. At times when the one female tested longer than the others was hungrier than usual she quickened her pace and thus ran into blind alleys which it is reasonable to expect she would have otherwise avoided.

Experiments with Designs.

The female sparrow was tried with something very like Dr. Kinnaman's apparatus 35, and 36.[1] Instead of boxes I used the gray glasses surmounted by cards carrying designs. The food was placed in the glass carrying the card with three horizontal black bars and alongside of this was placed a similar glass carrying a blank card. Next the food was placed in the glass with the card carrying a black diamond, and used as before along with the glass carrying a blank card. In the third series the horizontal bar and the diamond were used, the food being in the glass bearing the diamond-marked card.

Here again the place of the food-glass was irregularly shifted at either end of the cage and while the bird was behind me. Twenty tests were made in each series. If the bird alighted on the wrong glass she was allowed to go to the right one and take one bit of food. The following table shows the number of times she alighted on each glass in these experiments.

[1] Kinnaman: *op. cit.*, G, p. 114.

Horizontal Lines,	14	13	15	14	15	16	16	20	18	17	20
Blank,	6	7	5	1	5	4	4	0	2	3	0
Diamond,	18	14	17	16	17	20					
Blank,	2	6	3	4	3	0					
Diamond,	11	14	12	18	18	20					
Horizontal Lines,	9	6	8	2	2	0					

These figures are remarkable because of the entirely negative results obtained by Dr. Kinnaman with the monkeys.[1] The male monkey chose the right box 154 times and the wrong 146 times, the female monkey chose the wrong 30 times and the right 20 times with essentially similar apparatus. It will be seen from the second part of the above table that the Sparrow under the same conditions chose the right 49 times and the wrong 11 times out of the first 60 trials. The rate with which the bird came to discriminate between the horizontal bars and the diamond seems to show that the Sparrow has somehow come into possession of power of discrimination, at least in this particular, which the monkeys have not. It is probably true, as Dr. Kinnaman suggests in a personal letter to me, that the kind of coloration of food and the color markings of the species in question might enable the experimenter to tell in general beforehand what kind of designs the animals would discriminate.

General Summary.

The following conclusions may be drawn from the facts given in the preceding sections.

1. When tested with food boxes the fastenings of which are suited to the bird's structure, and with the maze, the English Sparrows' rate and method of learning are quite comparable with that of other higher animals. He profits very rapidly by experience.

2. There is some proof of ability to profit by the experience of others, or of imitation. However, before any description of the real nature of this imitation can be given, additional and varied experiments are needed.

3. His method of learning is one of "trial and error." There is no sign of reason or looking ahead and suiting of means to an end.

4. The scope of his attention is probably narrow. Any result of his activity which does not follow closely his definitely directed efforts he seems unable to profit by. He has great power of confining his actions to the matter in hand.

5. His persistency is most striking. Most of the birds tried in the complex maze never rested at all after they were once inside. They also returned again and again to make another attempt to enter the food box.

[1] Kinnaman: *op. cit.*, pp. 119-120.

6. These birds, both in the laboratory and outside, have shown the wariness which is popularly attributed to them. Those kept in the laboratory for months failed to show signs of becoming tamed. They test by various cautious means any new and strange object. Their fear is by no means a senseless one.

7. Although ideo-motor action plays a rather large rôle in their movements, they are able to modify their habits readily. They discriminate small differences in the apparatus and adjust their actions accordingly.

8. An interval of eight days between tests with the food-box on the male showed little, if any, effect on the memory. The results in the maze experiments where the interval was twenty-four hours, and the way these compare with the results on the monkeys tried without any appreciable interval, would seem to indicate that the Sparrow has a relatively good memory.

9. The tests on the "number sense," perhaps suggest that if the Sparrows cannot count, they have a very nice sense of position. Their progress almost parallels that of the monkeys, but they had smaller quarters to work in. The one female tried did not distinguish the forms. This may have been because she was so attached to place, or because she simply failed to notice them. This same female distinguished the standard colors, red, blue, green, and yellow, almost, if not equally, as readily as the female monkey. The designs the female Sparrow learned very early to discriminate, while the monkeys gave entirely negative results with the same apparatus. This may be explained probably by the fact that the black lines and diamond on the white card correspond more nearly with the markings of the Sparrow's food, her mate, and other birds of the same and different species. Such is not at all the case for the monkeys and they may be able to distinguish blotches of color, *i. e.*, markings corresponding more nearly to what they have to deal with in real life.

The biological significance of the mental traits mentioned above for the English Sparrow depends in large part on whether they are distinctive characteristics of this bird. Therefore comparative tests with birds of other species are necessary before an interpretation is attempted.